GRADIENT WOPRS THAT USE TWO WOPRS ARE ORTHOGONAL DIFFERENTIAL OPERATORS. EDGE DIRECTION IS OBTAINED BY FINDING \( \alpha(xy) = \tan^{-1}\left( \frac{G_y}{G_x} \right) \). ANOTHER APPROACH TO APPROXIMATE EDGE DIRECTION IS TO USE A SET OF EDGE TEMPLATE GRADIENT WOPRS. A SUITABLE SET OF 8 WOPRS CAN ESTIMATE THE EDGE DIRECTION TO WITHIN 45° (SEE FIGS 1.1 \& 1.2).

\[ P^*_k = G_1(xy) = \max_{k=1} G_1(xy), G_2(xy), \ldots, G_8(xy) \] AND \( \alpha = 45 \left( i - 1 \right) \frac{180}{\pi} \) DEGREES (\( i \) IS THE INDEX OF THE MAXIMUM GRADIENT OF THE SET). IS A COMMON ALGORITHM USED TO FIND THE MAGNITUDE OF THE GRADIENT AND ITS DIRECTION AT \( xy \) IN \( f(xy) \).

DO NOT TAKE ABSOLUTE VALUE OF \( G_0 \) WHEN SEARCHING FOR MAXIMUM \( G_2 \). \( P^*_k \) WILL ALWAYS \( \geq 0 \). EXAMPLE: 3-LEVIC ROBINSON

[Diagram of intensity slice (vertical edge)]

\[ P^*_k = G_2, 0° \] (H_5 WOPR) \( G_2 > 0 \)

\[ P^* = G_3, 180° \] (H_4 WOPR) \( G_3 > 0 \)
<table>
<thead>
<tr>
<th>Gradient direction</th>
<th>Prewitt compass gradient</th>
<th>Kirsch</th>
<th>Robinson 3-level</th>
<th>Robinson 5-level</th>
</tr>
</thead>
<tbody>
<tr>
<td>180° N1</td>
<td>[1 1 1; 1 2 1; 1 1 1]</td>
<td>[6 3 3; 5 0 3; 5 3 3]</td>
<td>[1 0 1; 1 0 1]</td>
<td>[1 0 1; 2 0 2; 1 0 1]</td>
</tr>
<tr>
<td>225° Northeast N2</td>
<td>[1 -1 -1; 1 -2 -1; 1 1 1]</td>
<td>[-3 -3 -3; 5 0 -3; 5 5 -3]</td>
<td>[0 -1 -1; 1 0 -1]</td>
<td>[0 -1 -2; 1 0 -1]</td>
</tr>
<tr>
<td>270° North N3</td>
<td>[1 1 1; 1 -2 1; 1 1 1]</td>
<td>[-3 -3 -3; 5 0 5; 5 5 5]</td>
<td>[0 1 1; 1 0 1]</td>
<td>[1 2 1; 1 0 1]</td>
</tr>
<tr>
<td>315° Northwest N4</td>
<td>[1 1 1; 1 -2 1; 1 1 1]</td>
<td>[-3 -3 -3; 5 0 5; 5 5 5]</td>
<td>[0 1 1; 1 0 1]</td>
<td>[1 2 1; 1 0 1]</td>
</tr>
<tr>
<td>0° West N5</td>
<td>[1 1 1; 1 -2 1; 1 1 1]</td>
<td>[-3 -3 -3; 5 0 5; 5 5 5]</td>
<td>[0 1 1; 1 0 1]</td>
<td>[1 2 1; 1 0 1]</td>
</tr>
<tr>
<td>45° Southwest N6</td>
<td>[1 1 1; 1 -2 1; 1 -1 -1]</td>
<td>[-3 -3 -3; 5 0 5; 5 5 5]</td>
<td>[0 1 1; 1 0 1]</td>
<td>[1 2 1; 1 0 1]</td>
</tr>
<tr>
<td>90° South N7</td>
<td>[1 1 1; 1 -2 1; 1 -1 -1]</td>
<td>[5 5 5; 5 0 -3; 5 5 -3]</td>
<td>[1 1 1; 0 0 0]</td>
<td>[1 2 1; 1 0 1]</td>
</tr>
<tr>
<td>135° Southeast N8</td>
<td>[1 1 1; 1 -2 1; 1 -1 -1]</td>
<td>[5 5 5; 5 0 -3; 5 5 -3]</td>
<td>[1 1 1; 0 0 0]</td>
<td>[1 2 1; 1 0 1]</td>
</tr>
</tbody>
</table>

Template gradient 3 x 3 impulse response arrays.

**Fig. 1.1 Edge direction using template sets of 8 each**
EXAMPLE OF APPLICATION OF TEMPLATES

(FROM DIP, W.K. PRATT)

Fig. 1.2 Application of template sets in Fig. 1.1